PROCEEDINGS

MEETING ON THE UNIFICATION OF STANDARDS FOR DIGITALLY ENCODED BRAILLE

UNESCO HEADQUARTERS
PARIS, FRANCE
2-3 MAY, 1978

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PROCEEDINGS

MEETING ON THE UNIFICATION OF STANDARDS FOR DIGITALLY ENCODED BRAILLE

Held under the auspices of the Committee on Rehabilitation, Training, and Employment, European Regional Committee, World Council for the Welfare of the Blind.

UNESCO Headquarters, Paris, France

2/3 May 1978

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Minutes of the Meeting on the Unification of Standards for Digitally Encoded Braille--UNESCO Headquarters--Paris, France--2/3 May 1978

Introduction

Some years ago the Dutch organization Stifting Voorlichten des Gehandicapten, under its chairman Professor Roelf G. Boiten, undertook a careful survey of the needs of the blind and visually impaired population for new or improved sensory aids and appliances. Among the top priority items in the final listing was a silent, cheap, portable, sturdy, reliable braillewriter for taking notes. (The world is still waiting for this device.) Also among that listing were braille reading machines with the design not specified. Limitations of time, money, and personnel took their toll, as they always do; and the Dutch group gradually concentrated on matters somewhat further down on their list about which they felt something practical and immediate could be done. (One result was an improved insulin syringe for blind diabetics.)

The progress of technological developments, about a decade later, resulting in relatively cheap integrated circuits and low-cost tape transports, and the nearly ubiquitous and astonishingly wide use of the compact cassette, caused a resonance in the minds of several researchers and developers with the idea of advanced note-taking devices. Hence it is certain that devices using a combination of compact cassettes, solid state circuitry requiring relatively low power, and highly efficient tape transports--and the crucial development of reliable tactile displays for braille characters--occurred simultaneously in the minds of several persons. (It is interesting to note that the

notion of recording braille in an auditory code form had been suggested as far back as 1966, for use on open reel tape machines, for braille books, coupled with one of the devices of the moving-braille-belt variety developed at MIT during this period.)

Pride of first appearance is that of the ELINFA Digi-Cassette, which was distributed within France for evaluation more than two years ago. Undoubtedly, when this development became known in other countries, there were many anguished decisions that had to be faced: do we continue with our development? Do we abort our development? Can we do better in terms of cost, or availability, or flexibility, or sophistication? These, and assuredly other, concerns went into the decisions of other manufacturers who, along with ELINFA, saw clearly the potential not only for note-taking in these new devices, but also applications allowing the reading of books, the creation of personal information retrieval systems, and the appearance of new ways to interact with computers and other peripheral devices. In fact, in any application where machine-readable information is available, it should be possible in theory to interface that information, capture it, and display it in braille.

At the same time these developments were occurring, braille itself was becoming a threatened medium of publication. The number of braillists in the volunteer sector was declining world-wide; and the costs of braille production in paper was rising, along with the cost of the braille paper itself (and these costs are still rising). Despite our ignorance of the acceptability of the available displays (generally of one line or part of a line) to the braille book

reader, the notion that these machines could stand in place of braille paper books became more and more attractive, at least to braille book producers.

But as more of these devices began to be announced, a gathering cloud of concern formed: each system used a different way of representing braille characters in its storage medium. The possibility grew that eventually we would face a situation in which the personal library of an individual user would contain a variety of classes of books, each in a magnetically encoded form that might be incompatible both with its neighbors, and some of which would be incompatible with the reading device that the user owned. In a market which was small and not rich to begin with, it seemed illogical to leave the possible proliferation of incompatible recordings of braille books to free market forces entirely, if only on the ground that the maximal user benefit would occur from the largest mass market for books in this form possible, i.e., in the lowest price for a machine capable of reading such books. Hence we could leave the question of acceptability of non-paper displays of braille aside for the time being, in the hope that the question of consumer acceptability would be explored separately.

Background of the Meeting

The above matters were the background for the concern expressed during the 1976 and 1977 meetings of the World Council for the Welfare of the Blind's (WCWB) Committee on Rehabilitation, Training, and Employment, and its Subcommittee on Computer Aided Translation of

Braille. The concern was repeated at the April 1977 meeting in London. An exchange of letters between AFB and the WCWB Secretary's office in Stockholm on the matter during November and December of 1977 led to the decision to hold this Paris meeting. Its chairman required the dual virtues of "presence" and of "wisdom," and we were fortunate that Murray Eden, Professor, Department of Electrical Engineering and Computer Science, Massachusetts Institute of Technology, not only accepted our invitation, but felt that this task was something he felt he "...had to do." Professor Eden is currently Chief of Biomedical Engineering and Instrumentation Branch, U.S. National Institutes of Health.

As is usual in many similar international meetings, no funds were available to underwrite travel of any of the participants. Nor did the time and venue suit some potential participants, who had less than a month before attended a conference for braille producers in Madrid. So it is a considerable tribute to the manufacturers who responded positively to our invitation and to the user and research community participants who attended, that they were present. A complete list of participants is given in Appendix I.

A special note of appreciation is due the manufacturers who participated vigorously in the proceedings. Given the nature and purpose of the meeting--called by what could be regarded as a representative of consumers, hopefully to define a common code for digitally represented braille--there would be every natural reason to suppose that postures of defensiveness and secretiveness would prevail; and that considerable resistance to the idea of a

common code would be thrown up. That this did not happen--indeed, the reverse might be said to have happened--is a tribute to the open-mindedness and cooperative attitude with which manufacturers arrived at the meeting.

The Agenda of the meeting was fixed in Stockholm and is reproduced in Appendix II.

Prior to the meeting, Mr. Bertil Bengtsson, a consulting engineer, was retained by the Swedish Institute for the Handicapped (Handikappinstitutet) in Bromma, Sweden, to explore the question of compatible codes, and to prepare a discussion document. Mr. Bengtsson sent out a questionnaire to a number of persons who had participated in the letter exchanges mentioned above, and undertook direct conversations with several of the manufacturers of digital braille equipments, both those in serial production, and those about to go into serial production. A list of those sent the questionnaire is given in Appendix III.

A copy of the report prepared from the responses and conversations is given in Appendix IV.

General Characteristics of the Several Present and Proposed Systems

Manufacturers and developers were given the opportunity early on to indicate the characteristics and features of present and proposed devices using digitally encoded braille for recreational, vocational, and note-taking purposes. Although information for the systems already in production (ELINFA Digi-Cassette, Braillocord, and Braillex) is available from the manufacturers, it is sketched here in brief to allow an overview of all such systems.

Triformation Systems, Inc.

This system, under development, uses six key and two control functions. A maximum 20-cell display uses modular cell units. The ASCII character code is used, allowing duplication of tapes at computer service bureau centers. Digital grade cassettes only are used. Two tracks are used, with bi-phase level recording (ANSI standard), giving 2.8 million bits. 300 braille pages can be contained on one cassette. No audio output capability is provided. Battery operation of the unit is contemplated as a possibility. Some thought has been given to using the device to feed a Triformations PBC press braille system.

Braillex/F. H. Papenmeier Elektronik

This is a closed loop random access search system device which can serve as an individual information storage and retrieval system; or as a note-taking device with digital and audio input; or a high-speed dictionary look-up type of device. It is microprocessor

based. The ability to read digitally encoded books is a secondary function, included in the production model, and for this function it is downward compatible with the other West German device, the Braillocord. The closed loop system uses a special data code incompatible with the reading function. For the closed loop function, a C-60 cassette contains a total of 700K characters on 2 tracks, using chromium dioxide tape of audio grade. Copies of data tapes can be made on another Braillex, or with a special copier. The tactile display gives 32 braille cells on a line (note the German format for braille books mentioned in Mr. Bengtsson's report). External connectors are provided for connection to electric typewriters, transmission over modem telelinks, calculator function, and modules for programmed learning with braille display. Serial production will begin shortly.

Braillocord/AID Elektronik and Schonherr Company

This device was intended from the outset as a book reader with a braille keyboard option for the writing function. An optional closed loop module is used for fast forward and backward searching of pages: pages recorded on one track are numbered; by keying in a page number and pressing the "Forward" or "Reverse" button, the desired page can be retrieved. The system uses a tactile display of 32 characters. Its data frame stores 32 lines of 32 characters of a braille page, using a two track audio cassette recorder. Four hundred pages can be stored on a C-90 cassette. An open reel tape recorder can be used with an external connection for additional storage. A 1200 baud rate is used with modem and telephone link.

For the rapid search function, an audio recorder with CUE and REVIEW capabilities is required (e.g., the BASF Model 9210, costing about US $90); but other low cost recorders may be used. Copies of cassettes made on the Braillocord can be made with ordinary audio recorders.

A first production series of Braillocords has been tested in West Germany during the past year. The device is in serial production, and a considerable number has been distributed to users. A calculator module is available. The system can be interfaced with the Model BD 80, from the Schonherr Company, for vocational applications.

Telesensory Systems, Inc.

Details on this device, intended for read and read/write applications, were not available at the time of the conference. The device is now in Phase II of its production design. Recommendation for code standards are contained in the specification sheet passed out at the meeting by Mr. Vitu, TSI's European representative, and this is attached as Appendix V.

ELINFA Digi-Cassette

This device records 300 braille pages on 2 tracks of a normal audio cassette. Digital and analogue material may be recorded on the same tape. The 1-7/8 (4.75 cm/sec) tape speed is used. Copies can be made on any high quality cassette recorder. Indexing is done through a simple tape counter with a braille read-out.

Data transmission rate is 600 baud (60 cells/sec.). The device uses direct mapping of the braille cell. A data link is used to convert to ASCII code for use with a modem and telephone link (the option is already available). It is not felt that start/stop bits are necessary for each character; start and stop are necessary only for the beginning and end of a recording block. Corrections of data are made by replacing blocks of information, i.e., by replacing 120 character blocks after editing. Options already available include calculators with braille and visual input and output; external link with electric typewriter; and ASCII converter already mentioned.

Clarke and Smith, Ltd. Computer Terminal

This terminal has a braille display of 48 characters at a time, and a memory of 96 characters. It is adaptable to transmission rates of 50 to 2400 baud, and uses computer grade transport and cassette tapes. Four tracks are used to record 1000 lines of 96 characters, using ASCII code, uniphase coded. The tape speed is 30 in./sec, rewind at 90 ips. They are considering the use of compact cassettes. Serial production is contemplated.

Osaka University Braille Production System

This prototype system uses floppy discs and a minicomputer to drive a paperless braille device for volunteer braille transcribers. It is microprocessor based, uses direct mapping of the braille code (but with a special deployment of the 8-dot cell). Paper books can be generated from the resulting magnetic tape. A five cell display is used in the read-out device. Editing of text is done in real time. The coding of characters is in accord with a new braille code for Kanji characters that is under development at present. High speed random access is possible only with floppy disc systems. A voice or cue tone is used in the cassette. Specifications and architecture of the system, and a proposal for a direct mapping code standard, are presented in the paper written by Dr. Sueda, the developer, which is attached as Appendix VI.

General Aspects of Braille Reading Devices

Given the wide disparity among the specifications noted above, how can we decide whether one or another--or none--of the encoding schemes they use ought to become part of a standard for world usage? In other words, what would have been the consequence were this meeting never to have been held? It seemed clear at the outset that at least two consequences would have occurred. First, the compatibility among a personal library users' cassettes collection would require the use of four to six different types of reading devices. Second, the user would have to use cassettes of at least two quality grades: digital and premium audio.

In an effort to touch upon these and other related concerns, the Swedish Institute for the Handicapped distributed the questionnaire in Appendix VII. The results were inconclusive, but among the agreements voiced were the following:

(1) Two track recording seemed preferred in Europe, whereas four track recording seemed preferred in the USA.

(2) 1-7/8 ips (4.75 cm/sec) tape speed is overwhelmingly preferred.

(3) Audio grade cassettes were preferred over digital grade cassettes.

(4) A mix of analog and digital information on the same tape is preferred to clock systems.

(5) Respondents disagreed on a preferred recording method from among those suggested in the questionnaire; at least four types exist at present.

(6) Direct mapping of the braille cell is preferred over any other representation.

(7) The use of start/stop and parity bits is not universally endorsed.

These results are helpful, but do not answer the presenting questions of the meeting. It was obvious that a different approach would have to be taken.

Book Reading Machines vs. Vocational Purpose Machines

One of the earliest distinctions to be made at the meeting was between the class of devices intended for book reading applications (replacing braille books in paper, in fact), and the class of devices meant for vocational applications. The note-taking function noted as defining functionally a third class of devices appeared to be seen as falling sometimes within the purview of book reading devices, sometimes in the group of vocational devices; much seemed to depend on the degree to which one needed access to precise locations of notes in putting a particular note-taking application in the book reading or vocational device camp.

Among the largest potential users of braille book reading machines will be the U. S. Library of Congress. They will be developing their own specification for a book reading device only, for a potential reader population of about 15,000 persons. Since the device will be looked upon carefully from the viewpoint of cost, reliability, and acceptability among readers of braille books, only those costs associated with the generation and distribution system concerned with paper braille will be used for comparison with the costs of a projected braille book reading device. Hence, their interest in book readers of low cost, in low cost production of the tapes to be read in such readers, and in a reasonable, but as yet undefined, criterion of reliability in which indexing capability is incorporated. There is a strong interest in capitalizing upon the potential availability of "clean"

photocomposition tapes as input to this system. But the compatibility of this book reading device and system with other purposes, such as those of students or those in the work force, is distinctly secondary; nor is compatibility of the coding scheme used for such books with the coding schemes of other device systems of very great importance. However, the point was emphasized that if a single standard of encoding for books were to be developed by this group, that standard would be taken into consideration in creating the specification for the Library of Congress system.

The French, using the Digi-Cassette, which is cabable of book-reading and notetaking functions, believe that there is simply not enough braille available; and are trying with the aid of these devices to create a system in which master tapes would be generated centrally, and cassette tapes generated locally, for distribution to Digi-Cassette users. The acceptability of the 12-character display has been examined by the Association Valentin Hauy, and it is thought that users adapt quickly to braille presented in this way; and, indeed, purportedly soon accept it as the equivalent of paper pages. Since 90 percent of the cost of microprocessor development lies in their programming, which would cause further delays, it has been thought reasonable to go with the present design so

that the availability of braille can be enhanced--this is the motivation which lies back of the whole design of the Digi-Cassette system in any case. If this results in the development of a two-tier system (microprocessor based, nonmicroprocessor based), that is a reasonable penalty if we can make braille more accessible. To this end, the French strive for a reasonably low-cost system, using standard audio cassettes (C-90's for reading purposes, C-60's for note-taking); using direct mapping technique; and bits only for start-stop of a recording block, and for pause (a total of 12 bits).

It seemed a concensus that it might be possible to achieve standards for encoding books for reading, perhaps with some provision for indexing (whether on tape or by an external page of hard copy). Standards for vocational machines would probably require further consideration. This applies also to notetaking devices, which were only briefly touched upon.

Functional Issues

Assuming that our focus is on devices for reading braille books, then, what are the issues to be examined? Among them are:

(1) What is the length of text to be considered? 100 pages? 200 pages? or--?

(2) Are cassettes to be used, or are we to consider tapes (or discs) of arbitrary length?

(3) Do we consider a read-only function, or reading and writing on the same machine?

(4) Does provision need to be made for an 8-dot braille? How should that allocation of dots be done?

(5) What is the needed power of the search system: to the page level, to labels defining data records, or only to specific digital information?

(6) Do we need to include provision for digital information only, or for both digital and analogue (speech) information?

(7) What is the tolerance for error rates? How is it to compare with the error rate for paper braille?

(8) What is a desired search speed and packing density? What of parity?

(9) Are we to consider recording on two tracks, four tracks, or on either at option?

(10) What is the level of reliability of the device wanted? By what criterion or criteria?

(11) What evidence is there that such machines will be found acceptable by braille readers?

As might be expected, this listing provoked a great deal of discussion. Among the points raised were these:

Costs and Error Rates

Note that in the area of audio cassette machines alone, the price ratio between the least costly cassette portable (around US $20) and the best professional cassette recorder/reproducer (e.g., the Nakamichi 1000, at about $2000) is about 100 to 1. Hence questions of cost and reliability and features is apt to be a complex matter.

In the Library of Congress view, cost is an important criterion. As already mentioned, were a change-over to take place to braille

display compact cassette based braille book reading machines, the total amount of funds available to do so would be that part of the total cost of producing braille books occurring after the generation of machine-readable Grade II braille. In this context, any demand for computer grade cassettes is a heavy demand on system costs, perhaps as much as an order of magnitude over the cheapest alternative in audio tapes. However, at least some users have reported excellent experience with very cheap audio cassettes (costing US $0.60 each) used on the $2000 Tech-Trans digital recorder: on tapes produced on this system error rates approached 1 in 5000 characters; this is comparable to the error rates in braille transcription under Library of Congress certification standards.

On the costs of braille books, it may be useful to note that it takes perhaps US $1000 to prepare a braille master, comprising 100 to 150 pages of text per volume, in 3 volumes. This implies 300K to 400K characters per braille book volume.

The conclusion is that an audio grade C-90 compact cassette may be adequate for a 2 track recording holding one ink print book, with acceptably low error rates of a 100 page ink print text at the standard speed of 1-7/8 ips (4.75 cm/sec).

Number of Tracks

Just what is the impact of choosing 1, 2, or 4 tracks? Is it possible to define a recording format for these choices, with variants for each track choice?

The overall consideration is of maximum recording density. This follows from the Library of Congress argument, above, which allocated system costs in such a way that overall braille book costs remain the same, or decrease from, the cost for paper braille books. But can arbitrary decisions be made on the information density desired? Can we in fact equate the costs of braille and ink print versions of the same book? Machine costs must be included, and amortized, over a certain number of books (i.e., the useful life of the reading machine). An arbitrary criterion of 1000 books (e.g., 4500 hours) was one suggestion for calculating the useful life of reading devices.

Cassette costs have a limit of downward pricing for the Library of Congress, whose specification requires a price of $1.25 per C-90. To aid costing out, one figure that might be kept in mind is the production costs for paper braille calculated by the Canadian National Institute for the Blind: $1.91 per braille page.

User Priorities

The discussion then turned from considerations of machine and system design, toward the requirements of users. A lively discussion in this area yielded a few general conclusions worth consideration in any system design:

(1) As a general goal, it seems desirable that in any system of digitally encoded braille books, one cassette become the equivalent of one ink print book. (But there could hardly be what one could call concensus on this point; there were

some demurrals which favored the use of more than one cassette for one book, on the ground of technical superiority of less densely encoded tape to signal degradation.) At the present time, with systems now available, densities of 300K to 400K characters per cassette are used, requiring at least two cassettes per ink print book. Thus, double the present recording density would appear desirable and attractive.

(2) Provision for digital and audio information recorded on the same tape is not a sine qua non; it is an attractive additional feature if speech can be recorded, but only if it comes, as it were, "...for free."

(3) So far as indexing and search capabilities are concerned, the major need is to access chapter and page of a book; some method of indicating a table of contents (as via the separate paper braille page of contents mentioned above); and a rough indication of where a given page may be found. These criteria apply only to normal books.
Dictionaries will have to be handled by use of closed loop indexing methods.

(4) Convenience and cost considerations involve many trade-offs. Thus, a cost-effective man-machine interface seems to point toward a one book-one cassette system, and easy indexing scheme, and no necessary capability of recording audio. But indexing in detail beyond a table of contents is required (as with a dictionary), search capability versus some criterion of cost level must be considered. Again, if a write function is desired, the machine design is impacted, since erase heads may have to be included even

on machines that are made only for playback for the majority of users.

(5) The important question whether we should aim for encoding for six-dot or eight-dot braille systems was not settled, except in the exception. That is, the inclusion of two potential dots at the bottom of the standard braille cell would allow for a universal code. Yet the format already in use for a small population of users in Japan requires what amounts to an 8-dot cell laid on its side for encoding Kanji (see Appendix VI). The silent assumption seemed to have been made that when and as such problems are encountered, they should be solved by using code conversion techniques.

How Do We Proceed Toward Standards?

Based on the discussion of the functional issues raised above, the concensus seemed to be that it would seem appropriate to use the systems now in existence, or now being developed, as a basis upon which to build, i.e., the schemes used by ELINFA, Braillocord, Braillex, TSI, Triformations, Inc., and Argonne Laboratories. Hopefully, this will also result in a specification for encoding that will be considered useful to the Library of Congress.

In an extraordinary gesture, ELINFA agreed to discuss with Braillocord the possibility of aligning their two audio-compatible direct mapping codes to a common standard. Thus, the possibility exists for a compatible book reading capability among three of the six systems in existence.

An extension of this gesture was accepted and, after much discussion, was proposed as a method for achieving some agreement internationally on a common code for digitally encoded braille on tape or disc that is audio-compatible and of the direct mapping type. The method was proposed in a motion, as follows:

> That manufacturers of present, and forthcoming, digital braille book reading systems and devices be invited to submit to a technical subcommittee the coding scheme they now have, in sufficient detail that the code representation can be replicated in the laboratory by any qualified technician; that the manufacturers also indicate what they intend to do in future; that they will each share the information submitted only if they themselves submit code information.

The information will be received by Bengt Lindqvist of the Swedish Federation of the Visually Handicapped, and sent to the members of the technical subcommittee, of which the suggested members are to be:

B. Bengtsson (Handikappinstitutet, Bromma, Sweden)

K. Küppers (Stiftung Rehabilitation, Heidelberg, W. Germany)

O. Sueda (Osaka University, Japan)

D. R. Maure (American Foundation for the Blind, New York, USA)

R. A. J. Gildea (MITRE Corporation, Cambridge, USA) (As Liaison with WCWB Braille Technical Subcommittee)

H. Paris (U.S. Library of Congress, Washington, D. C., USA).

A time limit for responses was set at about 60 days, e.g., 5 July 1978.

The Technical Subcommittee, after review of the manufacturer's responses, will recommend to the WCWB Committee on Rehabilitation, Training, and Employment, of which Mr. Lindqvist is Chairman, an internationally recommended standard for digitally encoded braille that is audio compatible and of the direct mapping type.

It was decided not to recommend a similar invitation for nonaudio compatible digitally encoded tapes to be used on closed loop (and usually, microprocessor-based) retrieval systems. Specifications for digital braille devices intended for vocational applications were not considered.

Information on Consumer Needs for Manufacturers

The matter of defining user's need in design of devices (the ergonomics), or the range, quality, and variety of braille materials wanted, or of market information generally of braille consumers, is obviously implied in much of the above discussion. Such information enters equally into rational design of reading devices, and of systems designed around reading devices, for braille books. Manufacturers and designers of advanced devices to enhance braille availability have little to draw upon in this area.

Mention was made of several activities and projects which will in a short time yield information that is relevant to manufacturer and designer needs for consumer information, among them surveys of braille users, the Library of Congress users, and general consumer needs, that AFB is undertaking currently. It was urged that this kind of information be brought directly to

the attention of manufacturers; alternately, that notice of availability of reports be disseminated in the pages of the WCWB Newsletter.

Concluding Comment

There are invariably widely divergent expectations for the outcome of international meetings like this conference. There are those naive enough to believe that a mere exchange of letters could lead to a meeting having the nature of a workshop, in which international standards for digitally encoded braille could be set down at once. Their naivete is underscored by those pessimists who believe that no international meeting at which manufacturers of sensory aids, vying for a significant share of a very small and specialized market, would ever seriously talk to one another (much less share information) in an atmosphere that could hardly be other than secretive and protectionist.

I believe that it became clear that neither group was right in the case of this meeting; that men of good will who meet in a common venue with a common purpose, and in the spirit of serving the population of blind consumers, can and did achieve a very significant step in progress toward the means of reducing the cost of braille books, while enhancing their availability, using the most advanced applications of technology. If the follow-on activity recommended by this group occurs as it should, it may yet be possible to achieve the international standard we sought, even without the need for additional meetings of this kind. This will represent an achievement of no mean moment, and participants at this meeting can be proud of their contribution toward this goal.

Participants at the 2/3 May 1978 Paris Conference on the Unification of Standards for Digitally Encoded Braille/UNESCO Headquarters/Paris, France

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Appendix I (continued) List of Participants - Paris Conference - 2/3 May 1978

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Appendix I (continued) List of Participants - Paris Conference - 2/3 May 1978

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Appendix II

Agenda

Committee on Rehabilitation, Training and Employment

MEETING ON THE UNIFICATION OF STANDARDS FOR DIGITALLY ENCODED BRAILLE

Place: UNESCO Headquarters, Meeting Room No.VIII,
7, place de Fontenoy, F-75700 Paris, France

Date: May 2nd and 3rd, 1978

DRAFT AGENDA

1. Opening of the Meeting
2. Roll Call
3. Adoption of the Agenda
4. Procedures
   a. Time Schedule
   b. Election of Rapporteur
5. Background of the Meeting - Developments up to now
   The Need for International Unification. Introduction by Mr. Bengt Lindqvist and Mr. Leslie Clark
6. A Survey of the Present Situation. Report by Mr. Bertil Bengtson
7. Presentation of Projects (Max. 10 minutes to each speaker)
8. Areas of Application of Digitally Encoded Braille. Discussion
9. How to Proceed
10. Other Business
11. Closing of the Meeting

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APPENDIX IV

Swedish Institute for the Handicapped
Questionnaire on Coding of Digital Braille
and
Study Report on Digital Braille Encoding

THE SWEDISH INSTITUTE
FOR THE HANDICAPPED

Planning unit

Bertil Bengtsson

1978-02-08

Questionnaire about the Braille recorder

		Agree	Oppose
1.	Standard Compact Cassettes should be used, because they are inexpensive and readily available. Comments:	☐	☐
2.	The information, analog (speech) or digital (Braille) should be recorded on one track and digital indexing on another track. Comments:	☐	☐
3.	The digital information should use a standard recording format. Comments:	☐	☐
4.	Data format should be the "Kansas City Standard", that has met a certain acceptance among manufacturers of "personal computers". Briefly the standard states that a logical 1 is recorded at 2400 Hz and a logical 0 at 1200 Hz with a bit time of 3,3 ms. Comments:	☐	☐
5.	The recorded character should be composed of a start bit, 8 data bits, optional parity bit and a stop bit, which is a common format for standard serial asynchronous transmission with in this case a 300 Baud transmission rate. Comments:	☐	☐
6.	The recorded character should be ASCII format for compatibility with ordinary computer equipment. A convenient (switchable) option when the recorder is used as a notebook might be a direct mapping of the 6 Braille dots onto the tape. Comments:	☐	☐

		Agree	Oppose
7.	The indexing information (optional) is recorded in such a way that play back at fast forward or reverse speed is possible of search words of e.g. 10 ASCII signs. Comments:	☐	☐
8.	Direct serial in/output confirming to standards such as RS 232C or CCITT V24 should be used. Comments:	☐	☐

Please send this form with your comments not later than 1978-03-01 to:

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Planning unit
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S-161 25 Bromma 1
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THE SWEDISH INSTITUTE
FOR THE HANDICAPPED

Technical department

Bertil Bengtsson/MB/bf

REPORT 1

1978-04-18

Encoded Braille Standardization

On behalf of the World Council for the Welfare of the Blind, committee on rehabilitation, training and employment, a questionnaire has been distributed to 39 receivers all over the world concerning the problem of unification of media and codes for Braille recording. In addition to this way of collecting opinions on the subject, personal meetings with representatives of some companies or institutions involved in development of this technique have supplemented the questionnaire.

The following corporations have made detailed comments to the questionnaire or in other ways submitted us their opinions on Braille recording:

- ELINFA (Electronique Linguistique Informatique Appliquées)
  France - manufacturer of a portable Braille recorder
- AID Electronic GmbH
  Federal Republic of Germany - manufacturer of ERAILLOCORD developed by G Heydt of Heinrich Herz Institut, Berlin
- F H Papenmeier Elektro-Apparatebau,
  Federal Republic of Germany - manufacturer of BRAILLEX developed in cooperation with Prof Dr Werner Boldt of Pädagogische Hochschule Ruhr, Dortmund
- Telesensory Systems Inc
  USA - a company that is developing a Braille recorder
- Triformation Systems Inc
  USA - a company that is developing a Braille recorder

1978-04-18

- Argonne National Lab, Arnold Grunwald
  USA - a manufacturer of a Braille recorder which in many ways differs from the above mentioned equipments

- Library of Congress
  USA - distributor of talking books

- Ph Dr Osamu Sueda, Osaka University
  Japan - researcher in the field of Braille recording

Furthermore we have received answers from a dozen persons and institutions interested in the subject but with few detailed comments to the questionnaire.

The opinions received have been structured in four main groups:

1. recording medium
2. recording method
3. data format
4. file format (page, line, character)

1. The recording media

The most important demands on Braille cassettes are considered to be:

- low cost
- contain a large quantity of information
- reliable and easy to use
- accessible all over the world

The Standard Compact Cassette fulfils these demands. Magnetic tape on ordinary 7" open reels contains approximately 4 times more information but are not se easy to use.

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The table below compares tape lengths, play time and storage capacity for Standard Compact Cassettes and open reel tapes. The figures stand for one track. The tape speed is 4,75 cm/s and the information is stored with 1200 bits/second (a Braille character consists of 10 bits).

	ft	m	min	number of characters
C 60	280	85	30	216 k
C 90	420	130	45	324 k
7" open reel	1200	360	130	936 k
7" LP open reel	1800	540	190	1368 k

One page of paper Braille contains about 1000 characters organized in 32 lines of 32 characters or 28 lines of 36 characters, the latter the standard format in German Braille books.

ELINFA, BRAILLOCORD and BRAILLEX already use the Standard Compact Cassette C60 or C90. TSI is going to use Standard Compact Cassettes. Triformation recommend computer grade cassettes.

BRAILLOCORD can be connected to an open reel recorder when reading "brick size" novels.

Library of Congress stresses upon that the recording medium shall be economical.

Arnold Grunwald appeals to the use of self threading cartridges.

The floppy disk appears to be a future medium in systems which use quick search facilities in digital information only. Below follows a comparison of several different mass storage techniques.

1978-04-18

Technique	IBM 3740 Floppy	Digital Cassette	Audio Cassette	Units
Data Capacity	3.0	6.0	3.0	Million bits (unformatted)
Average or Typical Access Time	.45	20	40 *	Seconds (*=manually controlled)
Data Transfer Rate	250	10.	1.2	k bps
Price of Commercial Package: Drive + Power + Controller	$1500	$1000**	$100	** Note that personal computing digital cassettes can be much cheaper than commercial drives
System Cost per Unit Storage	.05	.016	.003	cents per bit stored
Media Cost	$8	$4 $ 6.00	$2 $ 0.60	(unit quantity prices)
Storage Cost	2.2	0.55	0.55	cents/kilobyte of media

2. The recording method

Most of the answers are in favour of the following:

- two tracks on the tape
- tape speed 4,75 cm/s
- analogue and digital information on the same track

Papenmeier has in BRAILLEX the most advanced recorder. Both analogue and digital information are recorded on the same track. The digital information is partly Braille characters which are recorded at normal speed and partly search information which is used at a 50 times higher speed. Papenmeier thinks problems with cross talk will appear when using four tracks and too low signal levels when using half the normal speed (2,4 cm/s).

ELINFA uses a frequency shift keying (FSK) recording method.

AID uses in BRAILLOCORD "a broadband kind of recording".

Papenmeier uses in BRAILLEX a digital recording method.

The recording method is depending on the desired packing density or in other words, the number of bits/second (bps). A high packing density makes it difficult to use FSK and may imply the use of special digital cassettes. This kind of cassette has a better mechanical design and its magnetic qualities are fit for the recording of binary signals.

A strong opinion is that the recording bit rate (bps) shall be the same as the usual transmission rates for communication and data networks. In this case 300, 600 or 1200 bps can be used. 300 bps is in many people's opinion a too slow speed and leads to a misuse of the capacity of the tape and existing technique.

BRAILLOCORD uses 1200 bps, while ELINFA and BRAILLEX have a somewhat lower speed.

(As a comparison it may be mentioned that ANSI (American National Standards Institute) for digital cassettes recommend the packing density of 800 bits/inch (bpi). 1200 bps at 4,75 cm/s makes a density of 642 bpi.)

3 The data format

For two strong reasons it is a general opinion to let the Braille character be represented directly, so called direct mapping. Every dot in the Braille cell is then represented by a corresponding bit. The sequence of the bits on the tape must then be carefully examined, especially with the respect of the 8 dots Braille cell. By direct mapping a minimum number of bits/character is recorded which means larger storage capacity of the tape. In Braille text a lot of short forms are used which are not easily translated to another code without using a minicomputer.

Technical reasons may lead to the use of more bits than the minimum to represent a Braille character. To make the synchronization between different characters easier it can be suitable to add a startbit and one or a few stopbits.

ELINFA thinks that start- and stopbits are not necessary.

AID uses one startbit and two stopbits followed by a paus corresponding to one stopbit.

Papenmeier uses one startbit and one stopbit.

Since a microcomputer generally uses 8 bits at a time it is possible to add 2 control bits to the 6 databits in the Braille cell to get a more powerful search system. Papenmeier using microcomputer technique has done so.

Osamu Sueda says that in Japan 8 dots Braille cells will be used and therefore it is important to define the bit sequence for 8 dots too.

In Braille recording it is not considered necessary to use a parity bit.

The majority of the information suppliers thinks that the code translation between Braille and ASCII ought to be an option in the cases of machine - machine communication.

4. The file format

Braille recorders can, depending on application field, roughly be divided into three groups:

1. The portable note-book machine
2. The Braille book reading machine
3. The archives machine

The portable and compact battery supplied ELINFA has a display of 12 Braille cells and a buffer memory (page) of 120 characters or 10 lines. ELINFA can also easily be interfaced to calculators, type-writers and computers. Still it can be considered to represent the first group.

BRAILLOCORD and BRAILLEX have both a display of 32 Braille cells and 32 lines per page in the buffer memory but they have different search systems.

BRAILLOCORD has an interval of 2 seconds between every page and a line space of 50 ms to ease the synchronization line by line and page by page. When searching it is the intervals that are detected and counted. BRAILLOCORD can be considered to represent the second group.

BRAILLEX has a search system with search words and does not need any intervals. More exact information of the organization of the data in BRAILLEX has not been obtained. BRAILLEX can be considered to represent the third group.

The design of the machines has mainly determined how the information will be organized in pages and lines and how many characters every line shall have.

In Germany the problem of the page format has been discussed thoroughly. The number of characters per line in German Braille book printing differs from the number of characters per line in BRAILLOCORD and BRAILLEX.

A very important point is the design of an identification system for the Braille cassette, both on the tape and on the cassette housing.

Braille recorders can be used in many situations at home, at studies and at work. In the varying applications perhaps it might be necessary to accept different principal designs for economical or technical reasons. The following questions must then be considered:

- What will the consequences be if you have the need for using this technique in all these situations?
- Is it acceptable to standardize more than one Braille Cassette?
- Is it possible to solve the compatibility problem by having switchable recording standards on the more advanced Braille recorders?

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STANDARD CODE RECOMMENDATIONS FOR STORAGE AND RETRIEVAL OF BRAILLE DATA ON MAGNETIC TAPES

Reference: 2-3 May 1978 WCWB Meeting on the Unification of Standards for Digitally Encoded Braille at UNESCO Headquarters, Paris, France

1. Digital storage code: 6-bit braille with parity bit Standard Phase encoding
2. Cassette: Standard Phillips C-60 premium quality
3. Recording: Compatible with existing talking book recorder used in U.S.
4. Tape density: Low as ~~possible~~ feasible, approximately 600 bits per inch
5. Digital coding storage: 4 tracks
6. Analog storage: 4 tracks
7. Digital and analog storage same tape: Intermix coding
8. Tape length control: Mechanical external tape control
9. Search modes: Forward and reverse
10. Digital tape speed: 3 3/4 i.p.s. @ 1200 Baud or 1 7/8 i.p.s. @ 600 Baud

Appendix VI

A Proposal for the Standardization of the Digital Braille Recording on Compact Audio Cassette.

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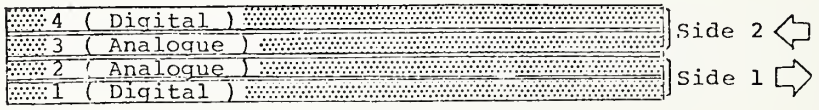
Dept. of Biol. Engng.,
Faculty of Engng. Sci.,
Osaka University,
Toyonaka, Osaka, 560,
JAPAN

Presented at the meeting held at Paris, May 2-3, 1978.

Proposal for the digital Braille file onto the compact audio cassette.

1. Both 4 track and 2 track recording systems are used, and in case of 4 track system outer tracks (1 and 4) are used for digital file recording and inner tracks (2 and 3) are used for analogue signal recording as shown below.

   (Note) After recording of analogue signal such as index or comment is easily possible on the cassette tape recorded by 4 track system or 2 track system without destroying the digital file by means of the 4 track cassette recorder such as for Learning Laboratory (L.L.).



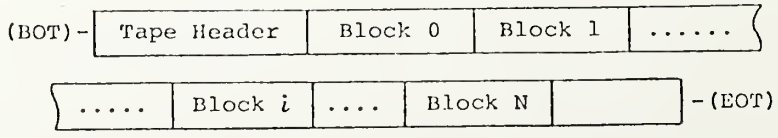
4 Track System

2 Track System

View from Oxide Side

2. For the digital Braille file, a file is recorded in block units, and one file is recorded on contiguous blocks, i.e. contiguous file is produced on the tape.

3. Each block is numbered, and the first block from the beginning of tape (BOT) is laveled zero and following blocks are laveled incremented number by one shown as below.



4. Block number is ranged from 0000 to FFFF in hexadecimal on one side of tape (A or B) and data size in one block is variable within the range that the maximum block number does not exceed FFFF in hexadecimal.

5. The block 0000 and the block FFFF is reserved for special use.

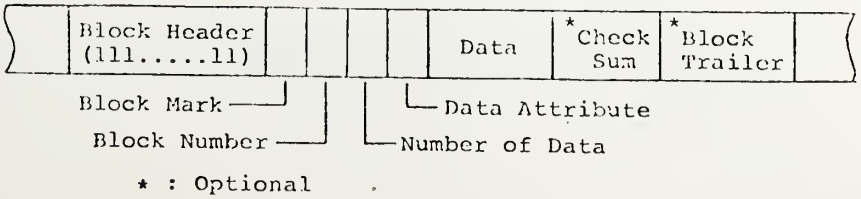
[For example]

[1] Block 0000 is used for file contents and for file file characteristic description such as following;

(1) Number of fles in the tape or in one side.
(2) U.D.C. number of the file or specially applied file number.
(3) Name of auther of the file.
(4) Name of translators (from foreign language).
(5) Name of editor.
(6) Title of the file.
(7) Total number of tape for the file.
(8) Ordered number of this tape.
(9) Date of published or translated.
(10) Name of Braille translator.
(11) Name of publisher or treater (+ Address).
(12) Title of original material (book).
(13) Date of published of original material (book).
(14) Number of edition of original material (book).
(15) Name of publisher or translator of original material (book), (+ Address).

[2] Block FFFF is used as the file end of the tape.

6. Each block is constructed by block header, block mark, block number, number of data, data attribute, data, check sum (optional) and block trailer (optional) from the beginning of the block to the end as shown below.

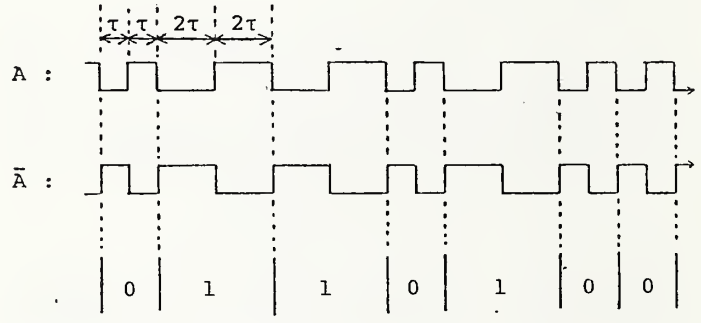


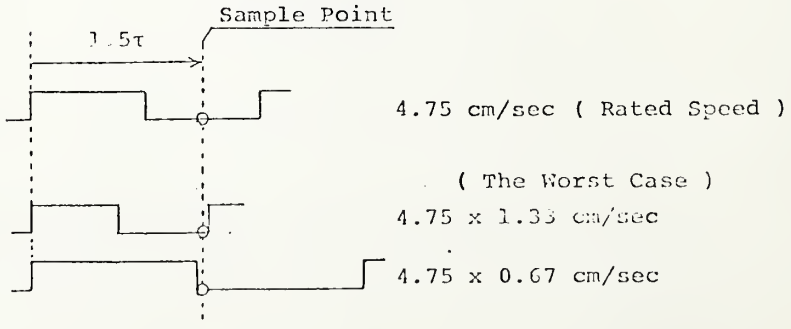
7. Signal format : (Now on Testing)

One bit of logical zero (0) is recorded as one cycle of 2f Hz and one bit of logical one (1) is recorded as one cycle of f Hz as shown bellow.

This recording signal format does not produce DC level shift on play-back signal and also it is easy to encode and decode signal by micro computer software just by checking the pulse width of low or high level.

The mean recording speed of 1200 bps or more is possible at 4.75 cm/sec tape speed by usual inexpensive cassette recorder with this recording format.





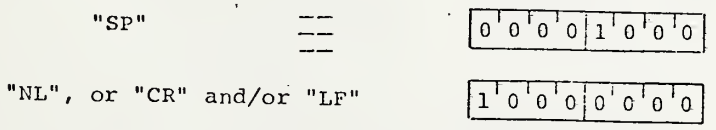
Signal is correctly detected against maximum speed variation of about ± 30 % from rated speed 4.75 cm/sec.

Proposal for the directly mapped digital Braille code

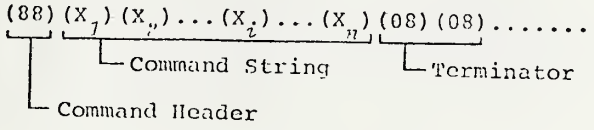
1. A Braille character is mapped onto 8 bit code.

2. Left column of a Braille character is mapped onto left nibble of 8 bit and right column of the Braille is mapped onto right nibble of 8 bit such as followings ;

3. Space code is defined as 08 in hexadecimal and new line code ("NL"), or carriage return code ("CR") and/or line feed code ("LF"), is defined as 80 in hexadecimal as followings ;



4. Hexadecimal number 88 is defined as a special code and/or command header, and this special code is terminated by two contiguous spaces such as following ;



(X_i) : Any 8 bit code

The string $(X_1)(X_2)\ldots(X_i)\ldots(X_n)$ is used as a command to communicate the user of the paperless Braille with the device and the command is terminated by following two space-codes.

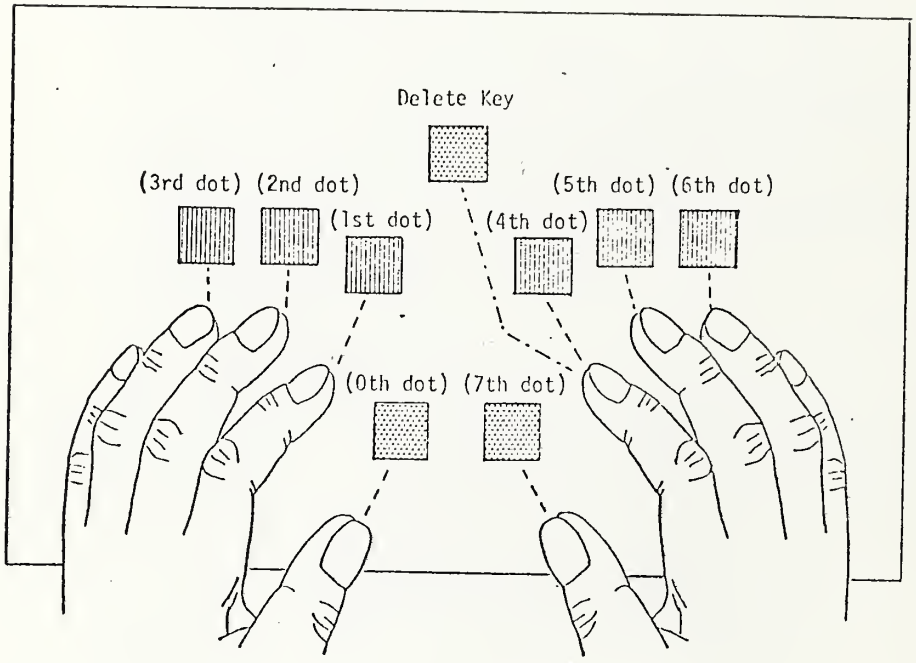
Following two command are specially defined;

[1] (88)(08)(08): This set of code is used as item separator or item header,

[2] (88)(80): This set of code is used as form feed code or page separator.

5. Hexadecimal number (00), or null data, is not used as a Braille code or no meaning as the Braille and this code (00) is used as space, leader, trailer or separator of a file just for the software handler.

A Braille key board for a computer system developed by Osaka University.



0th dot ○ ○ 7th dot
1st dot ○ ○ 4th dot
2nd dot ○ ○ 5th dot
3rd dot ○ ○ 6th dot

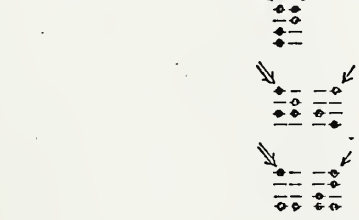
0th dot	Bit 7 (MSB)
1st dot	Bit 6
2nd dot	Bit 5
3rd dot	Bit 4
7th dot	Bit 3
4th dot	Bit 2
5th dot	Bit 1
6th dot	Bit 0 (LSB)

A space code (08) is keyed in by right thumb, a new line code (80) is keyed in by left thumb and the delete key may be pressed by right or left 1st finger.

An example of 8 dots new Kanji Braille system which is now trially taught in Japan.

In the system, one Kanji character is expressed by one, two or three 6 dots Braille code and additional 2 dots which are the beginning indicator of a Kaniji and the end indicator of the Kanji as shown below ;

Beginning Indicator　End Indicator



: 私 : I (my, me)

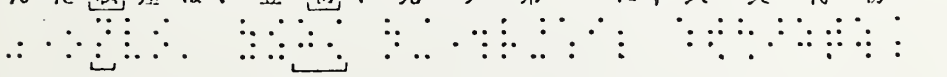
: 朝 : morning

: 夢 : dream

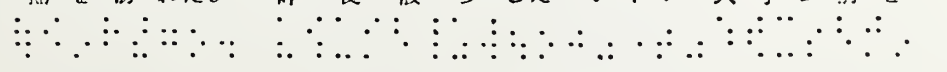
Three codes [(88), (80), (08)] are not used in new Kanji system as characters, and we defined them in our computer system as (80) is new line code, (08) is space code and (88) is special code whose function depends on the following string.

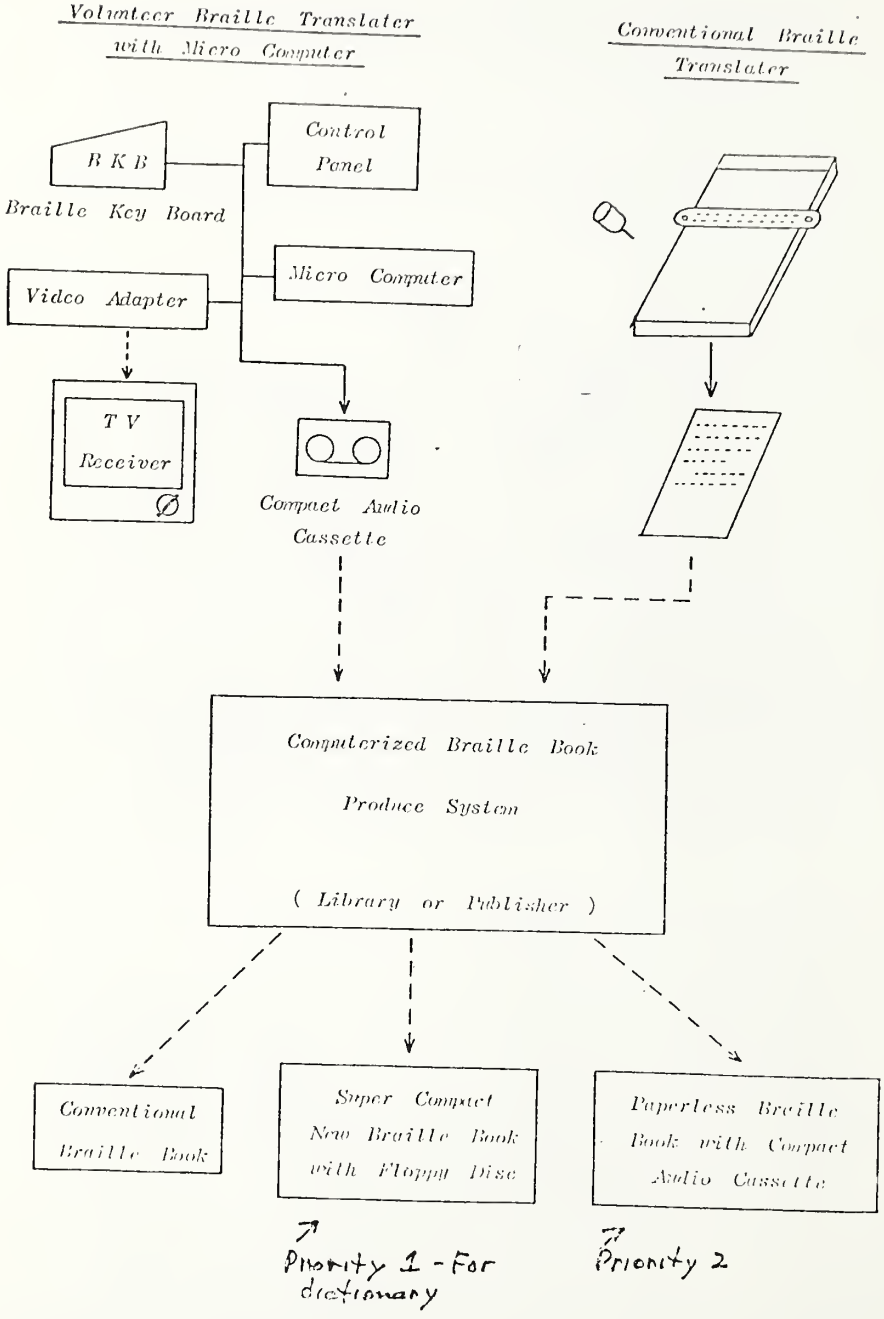
帝 国 ホテルの 豪 華 な 部 屋 で、一 夜 の 夢 を 語

んだ 私 達 は、翌 朝、先 ず 第 一 に、大 英 博 物



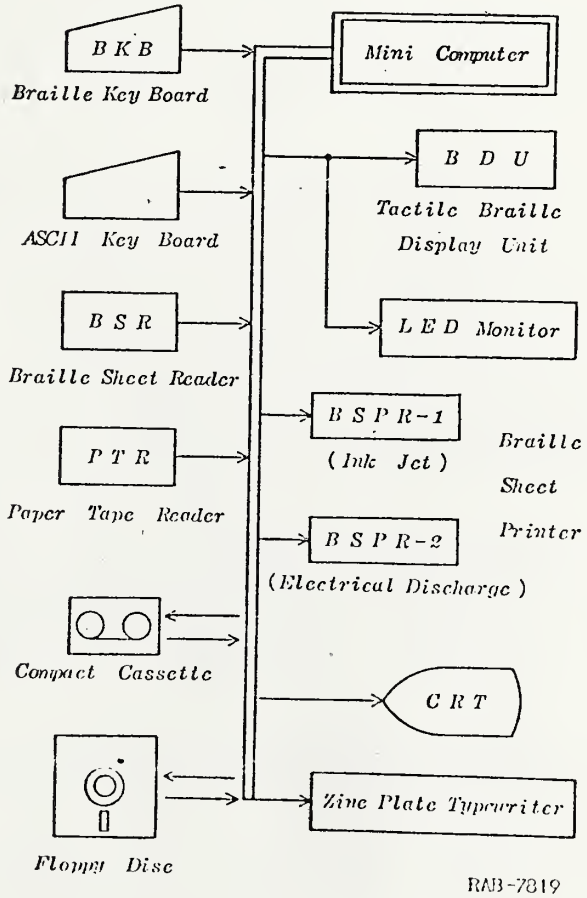
館 を 訪 れた。 昨 夜 散 歩 したロンドン 大 学 の 前 を




Volunteer Braille Translater
with Micro Computer
Conventional Braille
Translater
Control
Panel
B K B
Braille Key Board
Micro Computer
Video Adapter
T V
Receiver
Compact Audio
Cassette
Computerized Braille Book
Produce System
(Library or Publisher)
Conventional
Braille Book
Super Compact
New Braille Book
with Floppy Disc
Paperless Braille
Book with Compact
Audio Cassette
Priority 1 - For
dictionary
Priority 2

Computerized Braille Book Produce System

Developed by Osaka University.



OSAKA UNIVERSITY
DEPARTMENT OF BIOLOGICAL ENGINEERING
FACULTY OF ENGINEERING SCIENCE
TOYONAKA, OSAKA, JAPAN

(The comments to the draft of the proceedings of the 2/3 May Paris meeting for WCWB Newsletter.)

In your draft, you say that " That is, the inclusion of two potential dots at the bottom of the standard Braille cell would allow for a universal code." and " The silent assumption seemed to have been made that when and as such problems (that the eight-dot cell of which new two dots are laid on its side would be widely adopted in the Braille system in Japan) are encountered, they (Japanese) should be solved by using code conversion techniques.".

On the other hand, I have been understood about that problem as " Either of two eight-dot systems is adopted as as universal code, one system code to another system code conversion could be easily made by the computer or other conversion technique.", and " The decision about an universal eight-dot system will be made after the Paris meeting by the technical subcomitee settled at Paris.".

I would like to emphasize that we could not agree as an universal eight-dot code of its two potential dots at the bottom of the standard Braille cell at present without enouph dicussion about it.

The universal code setting of the eight-dot Braille cell is very important for future Braille world, because of the multi-dot Braille cell necessities not only in Japanese but also in another field such as in mathematics, music, computer program and so on.

I did not know exactly about the procedure of development of new eight-dot Kanji Braille system at Paris.

After I returned to Japan, I asked Mr. Kawakami who is the developer and promoter of new Kanji system about it.

Followings are the informations from him.

-- In order to use an eight-dot cell for new Braille system, big courage and careful preparations were required according to the progress of the development of that Braille system.

To make the decision for new two dots for eight-dot new Braille cell, many many tests were carried out by Mr. Kawakami and his coleagued mainly in 1968.

(An Example of Tests for Detectability of New Dots)

Two kinds of test materials were prepared. One was the text of which certain preposition Braille cell in Japanese which was formally constructed with

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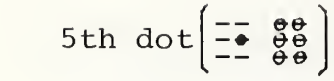
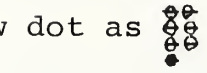
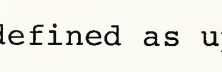
5th dot  of six-dot cell was redefined as lower new dot as  combining with following six-dot cell.

The other was the text of which same preposition was redefined as upper new dot as  combining with following six-dot cell.

With these two materials, two reading tests were made with two groups (A and B).

At the first stage, group A read the lower new dot material and group B read the upper new dot material and reading errors of each group about new dot were counted up.

At the second stage, the materials were exchanged as group A read the upper new dot material and group B read the lower new dot material and reading errors were counted up.

Through these tests, the following very interesting results were obtained that the upper dot material was more correctly read than the lower dot material by both group A and B.

== From the tests mentioned above, Mr. Kawakami determined the use of upper two new dots for eight-dot Braille system. ==

--.

After I returned from Europ to Japan, eight-dot new Kanji Baille system was widely taken up by every principal newspapers and the population of the eight-dot Braille user is going to rapidly increace in Japan, and also a new eight-dot Kanji Braille dictionary was produced by the computer and have been distributed widely in Japan.

Therefore, I earnestly hope that in your draft of the Paris meeting for WCWB Newsletter, the theme of eight-dot Braille code setting as an universal code is a future problem.

9th June, 1978.

Osamu Sueda
Osaka University

DIGITAL DATA RECORDING IN INFORMATION SYSTEMS FOR THE BLIND

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The All-Russia Association
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Intensive exchange of information in all areas of modern community puts forward quite new demands to technical means for storing and duplicating written information. Traditional forms of individual writing and book printing characterized by storing signs of the text on a paper medium in the forms available to human perception, i.e. in a graphic form which is understandable for the sighted; in Braille which facilitates an access of the blind to written materials; and in enlarged symbols which is available to the partially sighted, has a number of essential disadvantages. The disadvantages affect mainly Braille writing putting obstacles to vocational and social integration of the visually impaired.

Below are listed major disadvantages of the Braille system:

I) Information is not compact due to low discrimination ability of tactile sense and three-dimensional form of Braille signs.

2) A great amount of Braille paper is required. Braille printing involves labour consuming processes.

3) Low speed of manual writing due to considerable efforts necessary for punching thick sheets of Braille paper and impossibility to write Braille letters in one. It is difficult to correct and edit Braille materials.

4) Incompatibility of the Braille code with information systems used by sighted people. The situation evokes difficulties in utilization of information created by the blind as well as written materials available in sighted community.

5) Computerized text processing is available neither for Braille nor for ink-print texts. It is not easy, therefore, to develop automatic information retrieval systems and computerized teaching machines.

The majority of the above mentioned disadvantages could be eliminated provided that adequate forms of sign presentation are used both for storing and perception of symbols. It means that any text can be recoreded on a carrier in the digital form as a standard code which would provide more compact recording and higher reliability as well as facilitate editing and compatibility of the code with computer systems. Utilization of standard codes can result in free exchange of information between the blind and the sighted. In the process of reading standard codes get transformed into a form most convenient for the user. Output is presented in displays (a visual display is used for the sighted; a visual display with enlarged symbols is used for the partially sighted; a Braille display or synthetic speech are offered to the blind).

Individual writing or manual information input for further code recording is carried out with the help of an ordinary or Braille keyboard which would be followed by a system of automatic speech recognition in future.

One should not forget that a transition from traditional forms of Braille writing to code recording would undoubtedly entail a great number of administrative, psychological and other difficulties. Some attempts have been made to improve the Braille system, however, all the efforts turned to be a failure. The reason for the failure can be explained by the fact that the obtained results were not constructive enough to make blind people give up habitual forms of writing and book printing.

It is not wise, therefore, to introduce any digital information systems unless it is obvious that the can improve to the greatest extent possible the present systems and to make up for

all difficulties and expenditures connected with the would be changes.

It is evident that efficiency of digital text recording depends on an extent of standardization and unification of all technical devices involved in the system. With this in view the meeting convened by the WCWB Committee on Rehabilitation, Training and Employment is so important.

The major requirement that codes for the blind should meet is compatibility with standards of computing machinery and data transmission. Then it could become possible to use commercially available equipment and reduce expenditures on development and introduction of information systems for the visually impaired.

Before getting down to discussing a unified code recommended by the WCWB Committee on Rehabilitation, Training and Employment, I would like to make some general comments.

Any information code system for the visually impaired contains keyboard, output unit, memory and data communication device. It is necessary, therefore, to unify all elements of the system and not only types of data recording. Unification should cover also tactile displays for the blind, visual displays for the partially sighted and Braille keyboard.

All information can be subdivided into several categories:

1) Rapid information, i.e. the one that gets out-of-date rapidly. Handwritten texts which are supposed to be printed or typed, lecture summaries, abstract publications and newspapers belong to this category.

2) Information which it takes longer to get out-of-date. This category includes mainly periodicals and books on rapidly developing fields of science and technology.

3) Information which preserves its value for a long time. Classic fiction, books on fundamentals of science and technology, dictionaries, reference books, some manuals can be found in this group.

There is, apparently, no unified type of the recording of all the above mentioned categories of information, neither are unified carriers or devices admissible for all these categories of information. The types of recording and medium presented for consideration at the meeting are, consequently, not universal and can be used only for particular cases. It is reasonable to evaluate different memory units for possible utilization in information systems for the visually impaired.

DIGITAL CASSETTE TAPE-RECORDER

Several information systems for the visually handicapped based on principles of a digital cassette tape-recorder have bee recently developed, i.e. Grunvald's device, Braillocord, Braillex etc. They differ both in design and in recording type and also in recording equipment. Braillocord is based on a module principle and is attached to a standard cassette tape-recorder. Braillex is a large and independent device and it has its own digital cassette tape-recorder. A recording type suggested by the WCWB Committee on Rehabilitation employs also a standard compact cassette.

Below is Table I containing technical findings of different information systems based on digital cassette tape-recorders. The findings are refered to C-90 cassette. Information is recorded on one track, while the other track is used for indexing. It is supposed that information is recorded on four tracks.

It follows from the Table that memory capacity of the present codes for the blind does not exceed very much that of a standard talking book. A considerable increase in memory capacity (approximately in 50 times) can be obtained if modern types of digital tape recording, special digital cassettes and tape drives are used.

TABLE I

Recording type	Recording density (sign/mm)	Memory capacity (signs)	Equivalent amount of Braille pages of 750 signs	Equivalent amount of ink-print pages of 2500 signs
Speech at the speed of 2.38 cm/sec	0.6	$1.5 \cdot 10^5$	200	60
Recording standard suggested by the WCWB Rehabilitation Committee	0.8	$2 \cdot 10^5$	260	80
Braillocord	1.6	$4 \cdot 10^5$	520	160
Braillex	2	$5.3 \cdot 10^5$	700	200
Modern techniques of recording digital information on tape used in computing machinery (MFM, M^2FM)	25	$7 \cdot 10^6$	9000	2800

It is not reasonable, therefore, to use the present information systems and the recording technique suggested as a standard for recording books, dictionaries and other bulky publications. On the other hand, due to a possibility of erasing and re-recording information, it is advisable to use cassettes for recording newspapers, magazines and individual articles. Information can be recorded either in recording centres of by a consumer himself, with the help of communication channels. In the latter case recording is selective. It can by provided by two methods. For the first method a narrow-band two-way communication channel is required, e.g. a telephone channel can be used to request information from a data bank. Data transmission and recording are provided at a standard speed of telephone data transmission equipment. If a modem is inexpensive, the rate does not exceed 300 BAUD which corresponds to one printed page per minute. Obviously, the method can be recommended for obtaining small information quantaty, preferably for some professional use.

The other method provides high speed information transmission through one-way wide-band channel as a great number of parallel messages, transmission rate of each message being in correspondance with individual recording equipment. Information systems transmitting coded text information through a standard TV channel simultaneously with other TV programmes proved to be very promising for the purpose. They are Antiope, Teletext, View Data information systems. Information transmission rate in these systems equals to about 3800 signs per second. It follows that during a few hours one TV channel used simultaneously with a TV programme can provide information which is contained in scores of journals. A sightless person who knows a timetable of code transmissions can use a digital keyboard to set the cipher of a journal or a newspaper he intends to record. The information is recorded as a digital code on

the cassette. After he has read the text, he can erase it and re-use the tape for recording another issue of the journal.

It is very promising to use a digital cassette tape-recorder for storing handwritten texts, especially in view of the fact that a standard cassette can store about 500 Braille handwritten pages. For this purpose it is convenient to use a keyboard with a coding unit as a portable tape-recorder accessory. It is recommended to instal a buffer storage with memory capacity no less than 4096 bit in the same accessory. This device would provide editing of the text within a Braille page. The aecessory should have a Braille tactile display as a line with 8-I0 signs to check the recording.

FLEXIBLE DISK RECORDER

Flexible disks open wider opportunities for the blind to edit an entire manuscript . After the handwritten text is finilized and edited it can be typed by an electric type-writer, information being output from the disk. Braille printing equipment can produce simultaneously a Braille copy of the same text.

It is most promising to use inexpensive flexible micro-disks which have been widely used in computing machinery. A flexible disk (I0xI0 cm) can be used for recording $5 \cdot I0^5$ signs or 200 pages of ink-print text. The time required for retrieval of any part of information does not take more than 0.I sec. In contrast to cassette tape-recorder information systems, flexible disks can be used only in stationary conditions. Flexible micro-disks can be used in individual information systems instead of digital cassette tape-recorders thanks to their low price.

establish international cooperation to realize this programme. It is possible to involve governmental agencies in developing this programme since coded publications on videodisks could find its way in sighted community as well.

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